Monthly report No. 1
Fabrication of long wavelength array
by in-situ molecular beam epitaxy
(contract No. DAAB07-91-C-K762)

1.0 Summary of progress

In this reporting period, we have designed and constructed the major components of a MBE system for fabrication of long wavelength IR (LWIR) detector arrays. Among these components, the high temperature effusion cells were specially designed for alkaline earth fluoride (CaF_2 and BaF_2) growth. In the meantime, several multiple-layered fluoride films were grown on Si substrate to test out their crystallinities.

2.0 Design and test of high temperature effusion cell

The purpose of introducing the fluoride epilayers in this project is to form a buffer layer to accommodate a large lattice mismatch between LWIR detector layer and Si substrate. Since the growth of fluoride epilayers requires high source temperature (1200°C - 1300°C) to obtain reasonable growth rates (0.5 - 2Å/sec), the specially designed effusion cell has been made. Fig. 1 shows the designed structure of the high temperature effusion cell. The power consumption of the high temperature effusion cell, shown in Fig. 1, has been measured and the results are plotted in Fig. 2 vs. the cell temperature. The shadowed area provides the applicable cell temperature ranges required for the fluoride epilayer growth. Our data show that the power consumption corresponding to the shadowed area is still at a feasible level.

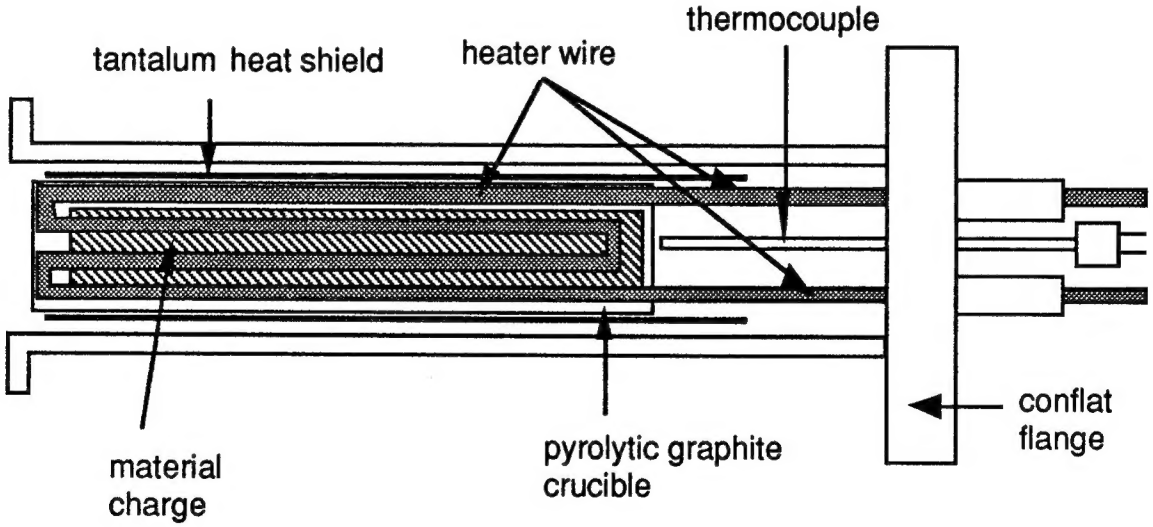

Fig. 1 Schematic of the high temperature effusion cell

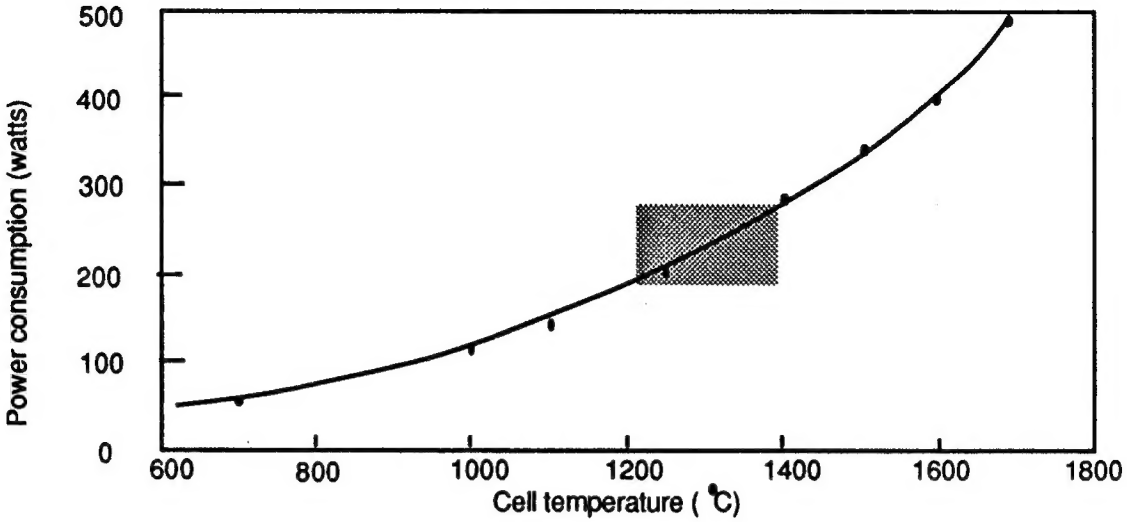

Fig. 2 Power consumption of the high temperature effusion cell

A pyrolytic boron nitride (PBN) crucible was first used as a crucible for the effusion cell. However, we have found that PBN crucible decomposed above 1200°C, as shown in Fig. 3. The unintentional doping elements, especially nitrogen, desorbed from the PBN crucible can incorporate with the epilayer during the growth. Therefore, the PBN crucible is not suitable and a replacement is needed. Among several possible alternatives, we have found that the pyrolytic graphite crucible is the best choice because it can be operated up to 1700°C without decomposition appreciably.

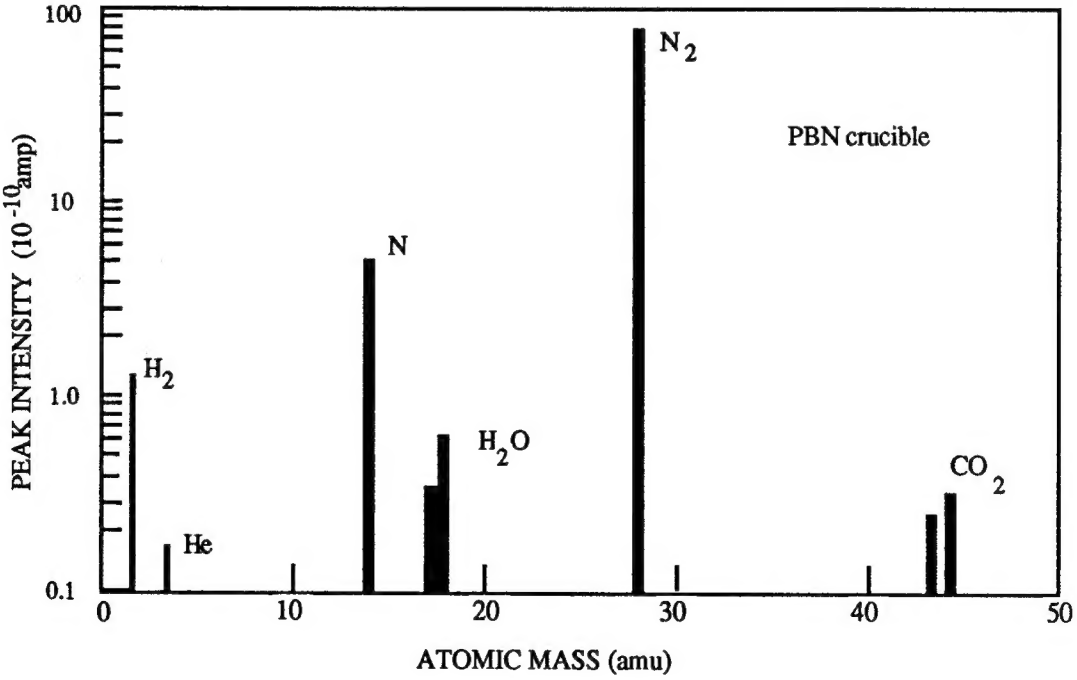

Fig. 3 RGA spectrum of the PBN crucible at a temperature of 1200°C

Several stacked fluoride epilayers (BaF_2(2500Å)/CaF_2(500Å)) have been grown on the Si substrate. Their crystal qualities are currently being investigated and the results will be presented in the following report. Work is in progress to optimize the crystal quality of fluoride-buffered films grown on Si substrates. The tasks for the next reporting period will also include the mask design for the in-situ MBE fabrication of LWIR arrays.